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# Ewe reproduction and lamb pre-weaning growth and survival traits of 'INRA 180' a synthetic sheep breed

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## Abstract

The 'INRA 180' is a new composite breed created from the Timahdite (50 %) and D'man (50 %) breeds at the INRA of Morocco. The development process were reported and the data of ewe weight, ewe reproductive and productivity, weights, growth and survival lamb traits were collected during six years and analyzed.

The results showed that ewe mating age, ewe mating weight, fertility, prolificacy at birth, fleece weight and productivity at 90 days for the 'INRA 180' ewes averaged 32.7 months, 43,3 kg, 91 %, 1.60, 1.74 kg and 25.5 kg, respectively. The average body weights at birth, 30 days, average daily gain between 10 and 30 days, average daily gain between 30 and 90 days, weight at 90 days, survival at birth ant at 90 days of 'INRA 180' lambs were 3.01 kg; 7.23 kg; 129 g/d; 170 g/d; 17.4 kg, 94 % and 84 %, respectively. It seems that the new breed promise a high potential merit in the agricultural livestock systems for increasing herd productivity and ovine red meat production in Morocco.

**Keywords:** Crossbreeding; D'man; fleece; INRA180; prolificacy; productivity; Timahdite

## Introduction

Increasing the number of lambs marketed per ewe and per year is a major way to improve the efficiency of meat production in sheep (Dickerson 1970). Because selection to enhance reproductive traits such as prolificacy in sheep is rather low (Bradford 1985), crossbreeding of local with highly prolific breeds is widespread in several countries, with the aim of increasing lamb production by exploiting both additive and non-additive effects of genes.

Local breeds in Morocco with more than 17 million heads are raised under different production systems. The D'man breed, which represents less than 3 % of the total sheep population, is characterized by small body size and body weight for ewes ranging between 30 and 35 kg. The D'man breed has a standardized phenotype, known by its three dominant colors (white, brown and black). The D'man breed, traditionally raised indoors in oases, shows slow adaptability under rangeland systems. However, D'man purebreds exhibit a long breeding season and sexual precocity, and it is the only prolific sheep breed in Morocco (Lahlou-Kassi et al 1989; Boujenane 1999; El Fadili 2001). Therefore, this breed could play a prominent role in crossbreeding to improve lamb production and herd productivity, since sheep productivity is more dependent on the prolificacy of ewes than any other component (Large 1970; Dickerson 1978).

Another native breed, the Timahdite, is one of the most important Moroccan breeds in number and geographical distribution. This breed which represent more than 17 % of the total sheep population, is characterized by a rather low prolificacy with less than 1.2 lambs per ewe at birth, a medium body size for adult ewes (40-45 kg), and a moderate growth rate (El Fadili, 2001). The Timahdite breed has a standardized phenotype, known by its white body color and brown head color. This breed is also known for its great adaptability to a wide range of pastoral and agro-pastoral livestock systems, where it is used mainly in pure breeding.

Because of their differences, Timahdite and D'man were crossed in a large crossbreeding program, starting in 1991 at El Koudia experimental station of the National Institute of Agricultural Research

(INRA) of Morocco. The program main objective was to evaluate crossbreeding performance in different mating involving the two breeds D'man and Timahdite with terminal sire breeds in a two stage crossing system (El Fadili 1996; El Fadili and Leroy 2000; El Fadili et al 2000; El Fadili et al 2001). Results obtained showed that F1 (D'man x Timahdite) crossed ewes gave superior productivity at weaning (28.3 kg) than Timahdite ewe (23.1 kg) mated to the same terminal meat sire breeds or D'man purebred ewes (22.5 kg).

However the two stage crossing system is difficult to develop in Moroccan small farms. Therefore, the development of a new synthetic breed from Timahdite and D'man local breeds was necessary. The new breed might be suitable for farmers who need to intensify lambs' production.

The early estimation of crossbreeding parameters (genetic breed differences, heterosis, recombination loss) of all traits studied showed positive heterosis and no significant recombination loss effects, indicating that crossbreeding of Timahdite with D'man breeds of sheep can result in an improved efficiency of production of marketable lambs (El Fadili and Leroy 2001). Furthermore, El Fadili (2005) reported that comparison of different proportion (0, 25, 50, 75 and 100 %) of D'man breed in the crosses animals between D'man and Timahdite breeds indicated that 50 % of D'man and 50 % of Timahdite genes was the optimum and suitable genotype to establish the new composite breed.

This paper presents the main results relative to phenotypic characteristics, ewes reproductive performances, lamb survival and growth performances of the 'INRA 180' synthetic breed.

## Material and methods

The development of the new breed was realized at the INRA El Koudia station, located 30 km south of Rabat on the Atlantic coast area of Morocco at an elevation of 150 m and an average annual rainfall of 500 mm. The parental native breeds Timahdite (T) and D'man (D) were involved each year in this program to produce reciprocal first crosses animals F1 (D x T and T x D). Then, males and females of each subsequent generation (Fl, F2, F3 and F4) were inter se mated. Each year new D and T rams, sometimes ewes, were introduced and used to maximise variability and limit inbreeding. The new breed was considered after the 4th generation, and hence no distinction was made at breeding among animals of the subsequent generations. During the development of the 'INRA 180' breed, all females that were able to reproduce were kept in the flock. Each ram was used during 1 or 2 mating seasons and no selection regarding coat colour was made to maximise variability.

All ewes were raised in similar management conditions, under an annual breeding cycle. Rams used for breeding were randomly mated to ewe lambs and mature ewes, with the restriction that mating among half-sibs or more closely related animals were avoided. Ewes were exposed to rams for a period of 45 days starting in July and penned in the ratio 10 to 20 ewes per ram of each generation. No objective selection was imposed during this study and culling was only practiced for fertility, old age and health problems. Ewes were flushed starting 10 days before breeding and kept indoors during the mating period. Ewes and their lambs were confined for 5 to 10 days after lambing and then only the ewes were let daily in the pasture of fallow or wheat stubble. Feeding was based on farm feed. Ewes were supplemented, depending upon available resources, pasture conditions and ewes requirements (maintenance, pregnancy, and lactation). The diet mixture consisted of a mixture of cereals, sunflower cake, barley or wheat straw, oat hay, minerals and vitamins. The ewe traits measured or calculated were mating age, mating weight, fertility (number of ewes lambing over number of ewes at breeding), prolificacy at lambing (number of lambs born alive or dead per ewe lambing), productivity at weaning (total litter weight weaned) per ewe at breeding) and ewe fleece weight.

The identities of newborn and of their dam, the date of birth, the sex, the birth type, the birth weight measured within 12 hours, and weaning type were also recorded. The weight of the ewes was recorded at breeding and lambing. Lambs were allowed to suckle their dams freely until weaning at 90 days of age. They were kept indoors during the days and had free access to hay and to a commercial creep feed. An annual program of vaccinations, deworming and dipping was carried out for all animals. The lambs were weighed individually at birth and every 20 days until weaning. The first weighing occurred 21 days after the birth of the first lambs in the flock. Lamb weights were adjusted to 10**,** 30, and 90 days

(W10, W30, W90 respectively), and average daily gains from 10 to 30 days (ADG10-30) and between 30 to 90 days (ADG30-90) were computed from those standardized weights. Lambs survival at birth and at weaning (at 90 days of age) were recorded and computed. Traits and performances of ‘INRA 180’ new breed was assessed using data of 518 ewe and 698 lamb records during six years.

Least-squares means for fixed effects were obtained from a fixed linear model analysis using GLM procedure (SAS 2000) for all traits. The fixed model used to analyze ewe mating age and weight, fertility, prolificacy, productivity and fleece weight included fixed effects of year of mating (2004, …, 2009), and ewe age at breeding (≤ 24, > 24-36, > 36-48, > 48-60, > 60 months old). For lambs survival, birth weight (BW), and ADG10-30 the models included the fixed effects of sex of lamb (male, female), birth type of lamb (single, twin, triplet or greater), and year of birth.

The models used to analyze lambs weight at 90 days and ADG30-90, included the same fixed effects as for BW, where birth types was replaced by weaning types (single, twin and triplet or greater).

## Results and discussion

### Phenotype of the ‘INRA 180’ breed

The ‘INRA 180’ animals do not have a defined standard and are not still fixed. However there are different phenotypes observed, where the dominant phenotype are animals with white body and brown head colours (Photos 1, 2,3 and 4).

The white colour frequency represent more than 85 % for body; more than 50% for legs and more than 55 % for neck. Brown colour in the neck represents more than 70 % and less than 10 % for black colour. Black colour with variable expression appears sometimes. The presence of black, brown and white colours are due to the presence of these colours in the D parental breed which had also these main colours.

The ‘INRA 180’ ewe is not horned but the ram is polled and shows also less important horns that have different sizes and shapes. The average height at withers is 64 cm for females and 73 cm for males. Mature body length averaged 70 cm for females and 80 cm for males. Mature weight averaged 43 kg for females and 58 kg for males. The average fleece weight of adult ram and ewe were 2.10 and 1.74 kg, respectively.

**Photo 1**. The "INRA 180" ewe

**Photo 2**. The "INRA 180" ram

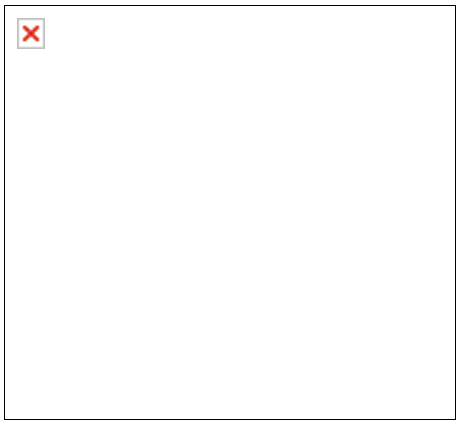

**Photo 3**. The "INRA 180" ram with 3 lambs

**Photo 4**. Bélier "INRA 180" ram

## Ewe mating weights and reproductive performances

The 'INRA 180' ewes used in this study were on average 32.7 months old. The ewe age varied from 19.1 months to 71.0 kg (Table 1). The body weight at mating for ewes was on average 43.3 kg. Mating weight was affected by age of ewe ($P<0.001$) and year ($P<0.05$). It increased progressively from 39.8 kg for ewes that were less than 24 months old to 47.1 kg for those that were more than 60 months old. The year of mating had no significant effect ($P>0.05$) on ewe mating weight (Table 1).

**Table 1.** Least-squares means ± S.E. for reproductive and fleece traits of 'INRA 180' ewes

| Traits Factors | Mating age, month | Mating weight, kg | Fertility, % | Prolificacy at birth, Lamb | Fleece weight, kg | Productivity, Kg/ewe |
|---|---|---|---|---|---|---|
| Number | 582 | 518 | 518 | 477 | 582 | 360 |
| Average ±SE | 32.7±1.34 | 43.3±4.78 | 91±28 | 1.60±0.57 | 1.74±0.55 | 25.5±8.20 |
| Breeding Ewe age | *** | *** | ns | * | *** | * |
| <24 months | 19.1±0.09$^{a}$ | 39.8±0.33$^{a}$ | 89±2 | 1.51±0.04 $^{a}$ | 2.06±0.04 $^{a}$ | 23.1±0.71$^{a}$ |
| >24-36 | 31.3±0.13 $^{b}$ | 43.0±0.40$^{b}$ | 93±2 | 1.57±0.05 $^{a}$ | 1.57±0.04$^{bc}$ | 24.3±0.80$^{ab}$ |
| > 36-48 | 43.4±0.14$^{bc}$ | 43.9±0.53$^{c}$ | 95±3 | 1.70±0.06 $^{b}$ | 1.47±0.06 $^{b}$ | 26.4±1.05 $^{b}$ |
| > 48-60 | 55.6±0.22$^{d}$ | 45.8±0.79$^{c}$ | 96±5 | 1.70±0.09 $^{b}$ | 1.73±0.09 $^{c}$ | 26.9±1.56 $^{b}$ |
| > 60 months | 71.0±0.26$^{e}$ | 47.1±0.93$^{c}$ | 95±5 | 1.74±0.11 $^{b}$ | 1.46±0.10 $^{b}$ | 27.3±1.81 $^{b}$ |
| Year | ns | * | * | * | *** | *** |
| 2004 | 44.3±0.22 | 43.0±0.97$^{a}$ | 93±4 $^{ab}$ | 1.55±0.10 $^{a}$ | 1.67±0.09$^{ac}$ | 25.1±1.55 $^{a}$ |
| 2005 | 44.0±0.19 | 45.0±0.70$^{b}$ | 98±4 $^{ab}$ | 1.51±0.09$^{ac}$ | 1.57±0.07 $^{a}$ | 26.8±1.30$^{ac}$ |
| 2006 | 44.1±0.16 | 41.9±0.57$^{a}$ | 91±4 $^{b}$ | 1.65±0.07 $^{b}$ | 1.78±0.06 $^{c}$ | 22.3±1.08 $^{b}$ |
| 2007 | 44.1±0.17 | 42.1±0.61$^{a}$ | 99±4 $^{a}$ | 1.42±0.07 $^{c}$ | 1.72±0.07 $^{a}$ | 22.9±1.45 $^{b}$ |
| 2008 | 44.1±0.12 | 42.8±0.45$^{a}$ | 89±3 $^{b}$ | 1.48±0.06c | 1.73±0.05 $^{a}$ | 22.8±0.89 $^{b}$ |
| 2009 | 44.0±0.11 | 42.8±0.42$^{a}$ | 91±2 $^{b}$ | 1.66±0.05 $^{b}$ | 1.45±0.04 $^{b}$ | 27.1±0.77 $^{c}$ |

*Least-squares means within a column followed by different letters differ ($P<0.05$), ns: not significant ($p>0.05$); * $p<0.05$; ** $p<0.01$; *** $p<0.0$*

The ewe mating weights for 'INRA 180' breed were higher than those observed for 'DS' (37.6 kg), another synthetic breed obtained from Sardi and D'man local breeds (Boujenane 2002), but lower than those of the French composite breed 'INRA 401' (64.7 kg) which was obtained by crossing Romanov and Berichon-de-Cher breeds (Tchamitchian et al 1986).

The 'INRA 180' mating weight was intermediate between the D (39.5 kg) and T (45.5 kg) parental breeds (El Fadili 2006). The fertility of 'INRA 180' ewes averaged 91 %. This trait was not affected by age of ewe ($P>0.05$) but was affected by year of mating ($P<0.05$). The fertility was higher than that of the 'DS' breed (83 %, Boujenane 2002) and similar to that of the 'INRA 401' breed (91 %, Tchamitchian et al 1986). The fertility reported for the parental breeds in the same conditions of management was 90 % for D and 94 % for T (El Fadili 2006).

The prolificacy at birth of 'INRA 180' ewes averaged 1.60. Prolificacy at birth was affected by age of ewe and lambing year ($P<0.05$). The lowest litter size was observed for ewes less than 24-months-old

(1.51) and the highest (1.74) for those that were more than 60 months of age (Table 1). The Prolificacy varied from 1 to 4 lambs. Single, twin, triplet and quadruplet litters represented 47, 44, 8 and 1 % lambs at birth respectively. The lowest prolificacy was observed in 2007. The ewe prolificacy at lambing realized by 'INRA 180' breed was lower than that of the 'INRA 401' (1.94) breed (Tchamitchian et al 1986) but similar to the prolificacy of the 'DS' breed (1.55, Boujenane 2002). The prolificacy reported for parental breeds in the same conditions of management was 1.19 for T and 2.08 for D (El Fadili 2006).

The fleece weight for 'INRA 180' ewe averaged 1.74 kg. The fleece weight was significantly influenced by age of ewe ($P<0.001$) and by the mating year ($P<0.001$). The highest fleece weight (2.06 kg) was observed for young ewes that were less than 24-month-old and the lowest (1.46 kg) for those that were more than 60 months of age. On average fleece weight of the 'INRA 180' breed was higher than that of the 'DS' breed (1.5, Boujenane 2002). But was intermediate to the parental breeds D (1.0 kg) and T (2.0 kg) (El Fadili 2006).

The productivity at weaning (90 days) for 'INRA 180' ewes averaged 25.5 kg of live weight. This productivity was significantly influenced by age of ewe ($P<0.05$) and mating year ($P<0.001$). The lowest performances were observed for young ewes that were less than 24-months-old (23.0 kg) and the highest (27.3 kg) for those that were more than 60 months of age (Table 1). Moreover, the highest productivity was obtained during 2005 and 2009 years. The productivity realized by the 'INRA 180' was superior to the productivity observed for 'DS' breed (19.4 kg, Boujenane 2002). The productivity of 'INRA 180' ewes, raised in the same condition of management, was superior to that realized by the prolific D (22.5 kg) pure breed which showed less adaptation at El Koudia station. While the productivity of T breed did not exceed 20.8 kg (El Fadili and Leroy 2001).

**Lambs pre-weaning weight, survival and growth**

The means for lamb weights at birth, 30 and 90 days for 'INRA 180' breed were 3.01, 7.23 and 17.4, respectively. These results were intermediate to those of the purebreds D (2.71, 6.50 and 14.8 kg) and T (3.68, 8.17 and 17.7 kg) (El Fadili and Leroy 2001). Weights at birth and at 30 days of 'INRA 180' lambs were slightly similar to those of Boujenane (2002) who reported respectively, 2.86, 7.21 and 16.4 kg for the 'DS' breed.

Lambs body weights were significantly influenced ($P<0.001$) by lambing year, types of birth or weaning and sex (Table 2). The lowest body weights were observed for lambs born in 2007 while the highest were for those born in 2005 and 2009. The male lambs were heavier at all ages than female lambs; the weight differences were 0.23 kg at birth, 1.23 kg at 30 days and 1.20 kg at 90 days. These values were comparable to those reported for 'DS' breed by Boujenane (2002) : 0.21 kg at birth, 0.42 kg at 30 days and 1.7 kg at 90 days.

**Table 2.** Least-squares means ± S.E. for weights, growth and survival of 'INRA 180' lambs

| Factors | Birth weight, kg | Weight at 30 days, kg | Weight at 90 days, kg | ADG10-30, g/d | ADG30-90, g/d | Birth survival, % | Survival at 90 days, % |
|---|---|---|---|---|---|---|---|
| Number | 659 | 550 | 491 | 507 | 488 | 698 | 657 |
| Average ±SE | 3.01±0.74 | 7.23±1.39 | 17.4±3.22 | 129±37 | 170±39 | 94±23 | 84± 36 |
| Sex | *** | *** | *** | ns | *** | ns | ns |
| Male | 3.04±0.06[a] | 7.05±0.12[a] | 17.3±0.35[a] | 128±4 | 174±4[a] | 92±1 | 82±2 |
| Female | 2.78±0.06[b] | 5.84±0.13[b] | 16.13±0.34[b] | 126±4 | 157±4[b] | 92±2 | 79±3 |
| Birth type | *** | *** | | *** | | ** | ** |
| Single | 3.37±0.05[a] | 8.44±0.09[a] | - | 155±3[a] | - | 97±1[a] | 90±2[a] |
| Twin | 2.76±0.04[b] | 6.52±0.86[b] | - | 118±2[b] | - | 91±2[b] | 80±2[b] |
| Triplet and + | 2.59±0.14[b] | 5.89±0.31[c] | - | 108±10[b] | - | 87±4[b] | 71±7[b] |
| Weaning type | | | *** | | *** | | |
| Single | - | - | 18.9±0.22[a] | - | 176±3[a] | - | - |
| Twin | - | - | 15.7±0.22[b] | - | 155±3[b] | - | - |
| Triplet and + | - | - | 15.5±0.88[b] | - | 166±11[ab] | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Years | *** | *** | *** | *** | *** | ** | ** |
| 2004 | 3.07±0.10$^{ac}$ | 7.38±0.20$^{ad}$ | 16.1±0.49 $^{c}$ | 146±6 $^{a}$ | 147±6 $^{a}$ | 92±3 $^{a}$ | 85±5 $^{a}$ |
| 2005 | 2.91±0.09 $^{c}$ | 7.55±0.20 $^{a}$ | 18.2±0.50 $^{ad}$ | 149±6 $^{a}$ | 181±6b $^{c\ d}$ | 94±3 $^{a}$ | 80±5 $^{c}$ |
| 2006 | 2.90±0.08$^{ca}$ | 6.81±0.18$^{bd}$ | 14.7±0.45$^{bd}$ | 116±5 $^{b}$ | 139±5 $^{a}$ | 96±3 $^{a}$ | 84±4 $^{a}$ |
| 2007 | 2.50±0.09 $^{b}$ | 6.50±0.20$^{bc}$ | 13.9±0.31$^{bc}$ | 122±6 $^{b}$ | 130±6 $^{a}$ | 79±3$^{b}$ | 68±4 $^{b}$ |
| 2008 | 2.94±0.08 $^{a}$ | 6.88±0.16 $^{c}$ | 16.6±0.43 $^{c}$ | 110±5 $^{b}$ | 174±5 $^{c}$ | 93±2 $^{a}$ | 79±4 $^{c}$ |
| 2009 | 3.13±0.06 $^{c}$ | 7.06±0.13$^{d}$ | 18.1±0.35 $^{d}$ | 118±4b | 189±4 $^{d}$ | 96±2 $^{a}$ | 86±3 $^{a}$ |

*Least-squares means within a column followed by different letters differ (P< 0.05), ns: not significant (p>0.05); * p<0.05; ** p<0.01; *** p<0.001*

Single-born lambs were consistently heavier at all ages by 0.70, 2.23 and 3.28 kg when compared to multiples born types. Lambs born as triplets or greater were lightest. In general, lambs raised as twins exceeded in weights to those raised as triplets or greater by 0.78, 2.55 and 0.19 kg at birth, at 30 and 90 days of age, respectively. The latest value indicates that at advanced age the differences between twins and triplets and more decreased significantly which seems to be due to the compensatory growth phenomena. The effects of type of birth and weaning on weights found in this study are in agreement with the findings of Boujenane (2002) and of El Fadili et al (2000).

Lambs survival at birth and at 90 days of the 'INRA 180' breed averaged 91 and 84 %, respectively. These traits were affected by type of birth and year of birth (P<0.01), but not by sex of lamb (P>0.05). The lowest lamb survival was observed in 2007 due to a lower quality of pasture due to the low rain fall in this year.
The lamb's survival decreased with litter size; single-born lambs had the highest survival at birth and weaning, 97 and 90 %, respectively. Whereas those born as triplets or greater had the lowest survival rates (Table 2). Therefore, more efforts are required to reduce lamb lost in larger litter size with care in managing and in using artificially suckled lambs practices. These results are in general in agreement with the reports of Boujenane (2002) and El Fadili et al (2000).

The lamb growth during pre-weaning period of the 'INRA 180' breed averaged 129 and 170 for ADG10-30 and for ADG30-90, respectively. The year of lambing significantly affect individual lamb average daily gains from birth to weaning (P<0.001). Lambs born in 2007 showed the lowest average daily gains (Table 2).
The birth types or weaning types had a large significant effect on lambs ADG10-30 and ADG30-90 during preweaning period (P <0.001), which is in part due to the small birth weight found in large litters. Single born lambs had consistently the fastest growth at all ages. Lambs born as singles were proportionately superior by 37 and 21 g/d than those born as twins and by 47 and 10 g/d than those born triplets or greater respectively for ADG10-30 and ADG30-90. The effects of type of birth or weaning type on growth traits found in this study are in agreement with previous reports (Berger et al 1989; Boujenane 2002; El Fadili et al 2000).

The sex had no significant effects on lamb ADG10-30 (P> 0.05), but had significant effect on ADG30-90 (P<0.001). Male lambs had always significantly fast growth compared to females by proportionately 2 and 17 g/d respectively. Similar observations were reported by El Fadili et al (2000) and Boujenane (2002).

## Conclusion

- The present study quantifies the performances of the new synthetic breed 'INRA 180'.
- The performance levels (reproduction, survival and growth traits) attained by the 'INRA 180' sheep were generally encouraging from a flock that was not selected. Thus introduction of the synthetic 'INRA180' breed into Moroccan sheep farms and flocks, especially those that have adequate management, either as a pure breed or as a maternal breed in the terminal crossbreeding with meat-type rams, may increase the sheep flock efficiency. This new breed would be a suitable animal for the livestock agricultural systems where feed resources are available.

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